

Further notes on the turrilitid ammonoids from Hokkaido— Part 2 (Studies of the Cretaceous ammonites from Hokkaido and Sakhalin—XC)

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Abstract. Six species of *Turrilites*, two species of *Mesoturrilites* and two species of *Mariella* are described on the basis of material from the lower and middle parts of the Cenomanian (mid-Cretaceous) in the central and northwestern Hokkaido. Several of them are well known for their worldwide distribution and occur in Hokkaido at correlatable stratigraphic levels. Three new species, *Turrilites complexus*, *T. miroku* and *Mesoturrilites pombetsensis*, are established, showing interesting but still questionable relationships with some previously known ones. Two species in open nomenclature require further study.

Key words: Cenomanian, Hokkaido, *Mariella*, *Mesoturrilites*, *Turrilites*

Introduction

The material from the Cretaceous Yezo Group of Hokkaido provides not only examples of well known, widespread species but also of other, little known or new ones. Selected examples of both categories are studied to improve systematic, biostratigraphic and biogeographic knowledge. The studied specimens came primarily from the Cenomanian of the Ikushunbetsu Valley of the Mikasa district, central Hokkaido, and the Abeshinai-Saku area of the Nakagawa district, northwestern Hokkaido. For the stratigraphy of the two areas, readers may refer to the two papers: Matsumoto (compiled, 1991, p. 3–5, 21–24) for the former and Matsumoto (1942, p. 180–214) for the latter. The material depends primarily on the collections of T. T. and T. M. In addition to them several specimens from these and also adjacent areas treated in the two papers written in Japanese, i. e., Nishida *et al.* (1997) and Hayakawa and Nishino (1999) are cited with brief remarks. An additional specimen from Abeshinai has been provided by M. Okamura.

Repositories.—The specimens treated in this paper are officially registered in the following institutions, with prefixes:

GK: Geological Collections, Kyushu University Museum, Fukuoka, 812-8581, Japan

GS: Geological Collections in Saga University, Saga, 840-8502, Japan

IGPS: Museum of Natural History, Tohoku University, Sendai, 980-8578, Japan

NMA: Nakagawa Museum of Natural History, Nakagawa, 098-2802, Hokkaido, Japan

UMUT: University Museum, University of Tokyo, Hongo, Tokyo, 113-0033, Japan

The specimen collected by T. T. is indicated with the previous number in brackets. Likewise, the specimen collected by T. M. and once stored in Umut under the heading of GT is indicated in brackets, for it is now officially transferred to GK.

Systematic descriptions

(continued from Part 1)

Genus *Turrilites* Lamarck, 1801

Type species.—*Turrilites costatus* Lamarck, 1801 (p. 101) by original designation.

Diagnosis.—Tightly coiled turrilitids with small apical angle. Ribs with no or two to four rows of tubercles; ribs and tubercles equal in number in all rows (modified from Wright and Kennedy, 1996, p. 349).

Remarks.—Besides well known *T. scheuchzerianus* Bosc, 1801, *T. costatus* Lamarck, 1801 and *T. acutus* Passy, 1832, two new species established below occur in the Cenomanian of Hokkaido.

Turrilites complexus sp. nov.

Figures 1, 2, 3A–D

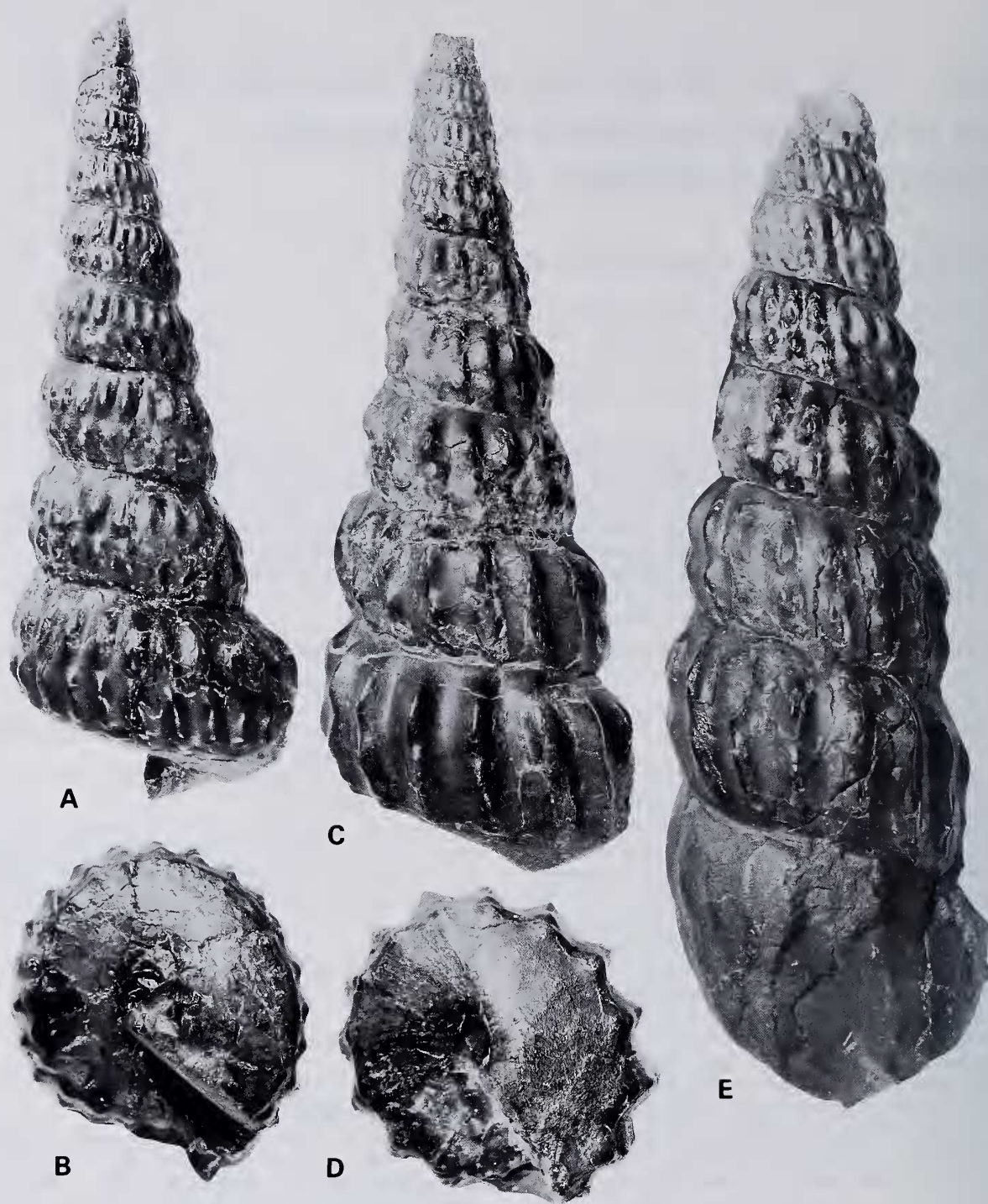


Figure 1. *Turrilites complexus* sp. nov. **A, B.** GK.H8552 (holotype). **C, D.** GK.H8553. **E.** GK.H8554. **A, C, E:** lateral views. **B, D:** basal views. Figures are all $\times 1.5$. Photos courtesy of M. Noda.

Table 1. Measurements of *Turrilites complexus* sp. nov.

Specimen	NW	Hp	Ht	D	ap	h	d	h/d	R(T)
GK.H8552	9.0	84.0	102.0	30.0	20°	12.0	23.5	0.51	26-22
GK.H8553	8.5	87.0	105.3	33.5	19°	14.5	28.2	0.51	22-16
GK.H8554	7.0	103.5	133.0	31.0	20°	15.5	31.0	0.50	24-17
GK.H8550	7.5	40.7	55.0	16.8	22°	7.2	15.0	0.48	31-22
NMA-151	7.5	33.8	—	13.6	19°	5.3	11.0	0.48	27-23 (?)

NW = number of preserved whorls, Hp = total height of the preserved shell, Ht = total height of shell from the preserved last whorl to the estimated apex, D = diameter of the preserved last whorl, ap = estimated apical angle. h = height of an exposed flank of a late whorl, diameter of the same whorl, R or T = number of ribs or tubercles in a given row per whorl, showing change with growth, if any. Linear dimension is in mm.

Material and occurrence.—Holotype is GK.H8552 [= previous S.40-5-16] (Figure 1A, B; Figure 3A, B) collected by T. T. in 1965 at Loc. Ik1100, on the right side of the River Ikushunbetsu, from the lower part of the Member IIb of the Mikasa Formation (see Matsumoto, 1991, p. 22, fig. 1). Paratypes from the type locality are GK.H8550 [= S.39-4-27] (Figure 3C, D), GK.H8553 [= S.40-8-7] (Figure 1C, D) and GK.H8554 [= S.50-4-13] (Figure 1E), collected by T. T. in 1964, 1965 and 1975 respectively. Another paratype is a large but incomplete specimen, GK.H8558 [= previous GT. I-3150] (Figure 2A, B), collected by T. M. in 1938 at Loc. T591b on the left side of the River Abeshinai of the Nakagawa district. Also NMA-151, collected by T. Nishino at "Loc. Y" [Yasukawa] and illustrated by Hayakawa and Nishino (1999, pl. 10, fig. f) as *T. costatus*, should now be transferred to this species. There are more examples from both Mikasa and Nakagawa districts, but at present they belong to private possessions.

Diagnosis.—Turreted shell with a low apical angle, showing the ontogenetic change of ornamentation from numerous, crowded ribs with scarcely discernible tubercles to the diagnostic ribs with tubercles of moderate intensity like *Turrilites costatus*. In addition to the three rows of ribs or tubercles like those of *T. costatus*, there are clavate small tubercles of the fourth row, from which radial ribs run on the lower (or basal) surface to the narrow umbilicus. The concave zone between the upper and lower ribs is faint in youth, moderately distinct in the middle or main stages, and may become indistinct at the last stage.

Description.—The available specimens are scarcely affected by secondary deformation. They are, however, incomplete in that the very apex is lacking and their last whorl is more or less deficient. The holotype (Figure 1A, B; Figure 3A, B) and a paratype, GK.H8553 (Figure 1C, D) are slightly over 100 mm in the original height. In both specimens the preserved last whorl is still septate. GK.H8554 (Figure 1E) is the largest of the four specimens from the type locality, showing 133 mm in the total height of the shell. The body chamber is preserved in this specimen, but its apertural part is destroyed. GK.H8550 (Figure 3C, D) shows the characters of the young shell, although the initial part is lacking.

Despite some deficiencies mentioned above, they show as a whole the above-described diagnostic characters. This is also supplemented by the measurements (Table 1).



Figure 2. *Turrilites complexus* sp. nov. A, B. GK.H8558. A is the detached lower whorl of B and slightly turned clockwise to show clearly the saddle between E and L. Figures are $\times 1$. Photos by C. Ueki.

Minor differences between specimens can be regarded as infraspecific variation. For instance, the decrease in the rib density with growth varies from individual to individual (see Figure 4). The tubercles on the last whorl of GK.H8554 (Figure 1E) become weaker than those of the preceding whorls, but a similar feature often occurs in the last whorl of the turrilitid ammonoids.

The septal suture at a young stage is exposed partly on GK.H8550. L is situated on the concave zone between the

upper and lower ribs. The suture of a late growth stage is much incised (see Figure 2). The E-L saddle is so broad that L is shifted toward the lower whorl seam and U is in the middle part of the lower whorl face (Figure 2A). The incised branches of an element (probably I) are extended from the concealed side (Figure 2B).

Comparison and discussion.—With respect to the characters of the middle to late growth stages this species resembles *Turrilites costatus* Lamarck, but it is distinguished by the

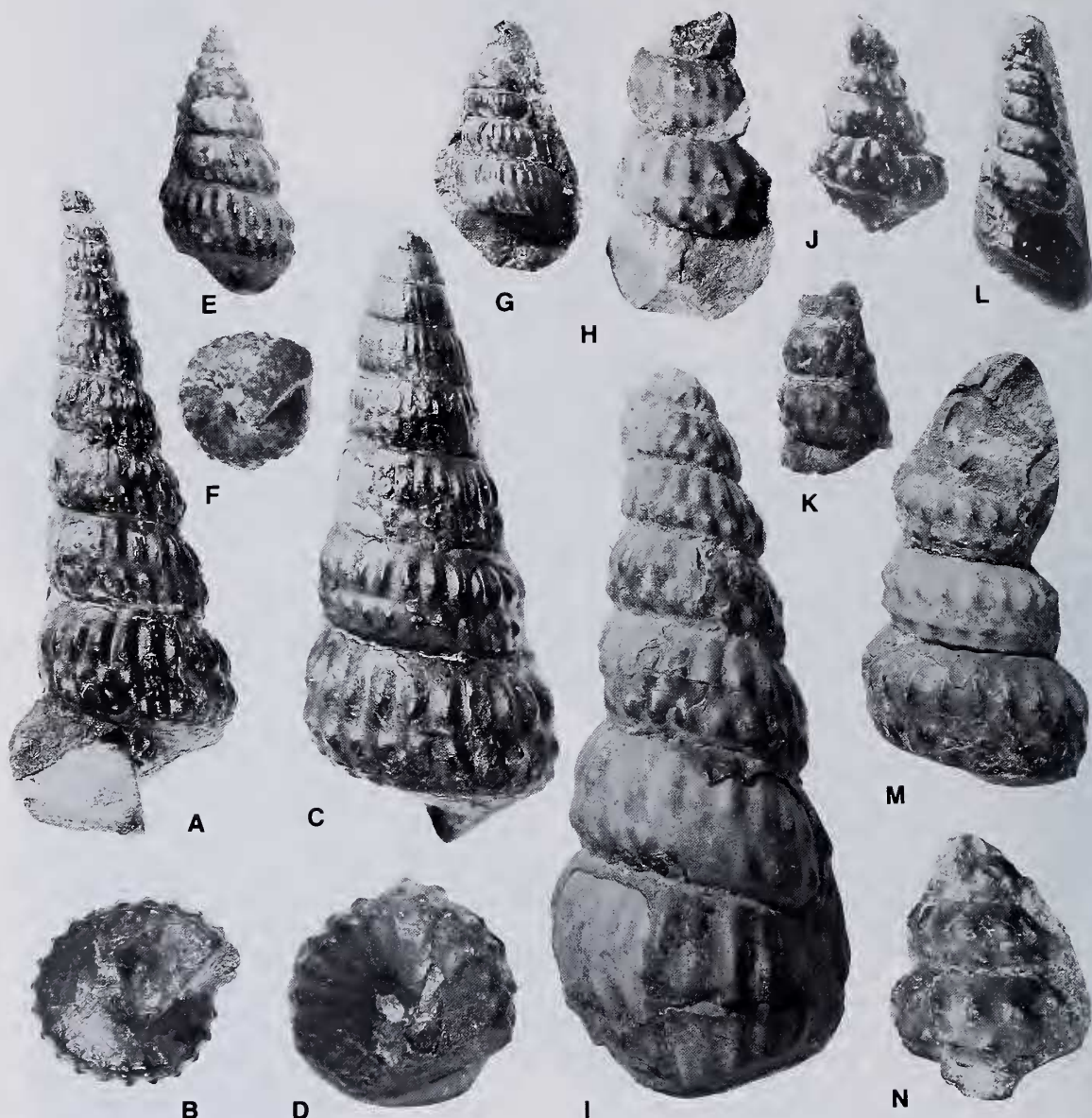


Figure 3. A-D. *Turrilites complexus* sp. nov. A, B. GK.H8552 (holotype). Fig. 3A is 180° turned from Fig. 1A; Fig. 3B is another basal view in a different light from Fig. 1B. Figures slightly over natural size. C, D. GK.H8550, lateral and basal views, $\times 2$. E, F. *Turrilites* aff. *costatus* Lamarck. GK.H8549, lateral and basal views, $\times 2$. G. *Turrilites scheuchzerianus* Bosc, 1801. GK.H8563, half exposed from the rock matrix, $\times 1.5$. H, I. *Turrilites costatus* Lamarck, 1801. H. GK.H1373, $\times 2$. I. GK.H8560, $\times 1$. J-M. *Turrilites acutus* Passy, 1832. J. GS.G114, $\times 2$. K. GS.G113, $\times 2$. L. GS.G127, $\times 1.7$. M. GK.H8559, $\times 1$. N. *Mesoturrilites* cf. *aumalensis* (Coquand). GK.H8562, $\times 2$. Photos courtesy of M. Noda (A-D), N. Egashira (G, H, J-L) and C. Ueki (I, M, N).

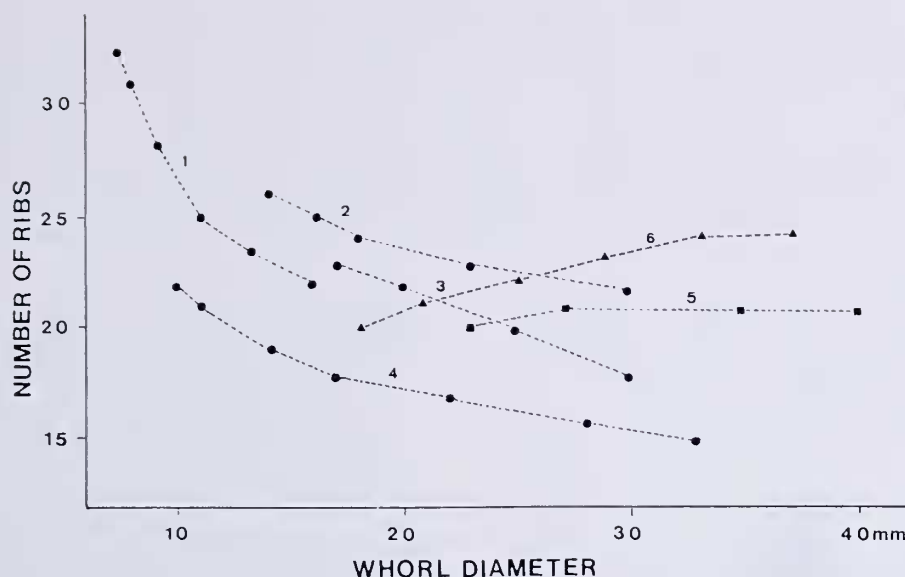


Figure 4. Diagram showing the ontogenetic change of rib density in some representative specimens of *Turrilites complexus* sp. nov. (small solid circle), *Turrilites costatus* Lamarck (solid square), and *Turrilites scheuchzerianus* Bosc (solid triangle). 1: GK.H8550, 2: GK.H8552 (holotype), 3: GK.H8554, 4: GK.H8553, 5: GK.H8560, 6: BG5 GSM 7772 (Sharpe, 1857, pl. 26, fig. 1).

presence of spirally elongated tubercles of the fourth row. In younger growth stages the two species are undoubtedly different in ornamentation. Also, as is shown in Figure 4, in contrast to the ontogenetic decrease of rib density in *T. complexus*, *T. costatus* maintains uniform density with growth.

With respect to the morphological characters of young shells this species resembles *Turrilites scheuchzerianus* Bosc in showing interrupted ribs on rather flat or only gently convex flank, without or with very faintly appeared swellings. The number of ribs seem to vary between individuals in *T. scheuchzerianus*, but the decrease of the number with growth is not so remarkable as in *T. complexus*. Again, the presence of the clavate tubercles of the fourth row in *T. complexus* is a distinction. As to the characters of the middle to late stages *T. complexus* is clearly different from *T. scheuchzerianus*.

Stratigraphically *T. complexus* first appears from a lower level than *T. scheuchzerianus* and *T. costatus*. Hence, it can be presumed that the latter two species may have branched from the former almost simultaneously or successively at slightly different times.

The middle-aged shell of this species resembles *Mariella* (*Mariella*) *oehlerti* (Pervinquière, 1910) (see also Matsumoto *et al.*, 1999, p. 109, figs. 2–4; Matsumoto *et al.*, 2000, p. 8, fig. 3) in the whorl shape and ornamentation. The latter shows a wide extent of variation in the density of tubercles, as Klinger and Kennedy (1978, p. 32, fig. 9) have demonstrated. But the ontogenetic change of ornament in the latter species is not so great as in *T. complexus*. On the average tubercles are predominant over ribs in *M. (M.) oehlerti*, but ribs in the upper row characterize the middle-aged whorls of *T. complexus* as in the main part of the *T. costatus* shell. The spirally elongated tubercles of the

fourth row are common in *M. oehlerti* and *T. complexus*.

There is, however, to some extent infraspecific variation. For instance, Klinger and Kennedy (1978, p. 33) pointed out the presence of "variety A" in *M. (M.) oehlerti* "which differs from the "typical form" in possessing moderately to well-developed ribs". Numerous specimens of *M. (M.) oehlerti* from Zululand and Natal in South Africa seem to be more or less fragmentary, as are shown by the illustrations by Klinger and Kennedy (1978, pl. 6, figs. H–N, P; pl. 7, fig. G). If fragmentary pieces of a middle-aged shell of *T. complexus* were mixed with them, they might be regarded as the ribbed variety of *M. (M.) oehlerti*.

Discussion.—This species occurs in the lower part of the Member IIb of the Mikasa Formation. This unit is biostratigraphically defined as the Zone of *Mantelliceras japonicum* - *Sharpeiceras kongo*, that is, the second unit in the three subdivisions of the lower Cenomanian in the Ikushunbetsu Valley. It was erroneously listed as *Turrilites costatus* in the stratigraphic notes by Matsumoto *et al.* (1969, p. 287) and also Matsumoto (*in*, Matsumoto, 1991, p. 22). It occurs also in the Abeshinai Valley of the Nakagawa district. A specimen from Loc. T591b is referable to the middle or upper part of the lower Cenomanian, because Loc. T591b is above Loc. T591a, where *Mesoturrilites* cf. *aumalensis* (Coquand, 1862) (see description in later pages) was obtained, and well below Loc. T591d, where *Turrilites acutus* Passy, 1832 (see below) occurred. The "Locality Y" of Yasukawa, where a specimen of *T. complexus* (NMA-151) was collected, is a fairly extensive exposure of strata, about 70 m in thickness, but the stratigraphic level of NMA-151 is not precisely recorded by Hayakawa and Nishino (1999). Although they ascribed the entire thickness of the exposed strata of "Loc. Y" to the middle Cenomanian, the assignment is questionable, because *Cunningtoniceras*

Table 2. Measurements of *Turrilites costatus* Lamarck.

Specimen	NW	Hp	Ht	D	ap	h	d	h/d	R(T)
GK.H8560	6	105.0	150.0	41.0	20°	20.0	37.0	0.54	22
NMA-145	5	115.0	165.0	45.0	23°	24.0	42.5	0.56	ca.21

Legend as for Table 1. In NMA-145 about 120° of each whorl is embedded in the rock matrix.

Table 3. Measurements of *Turrilites* aff. *costatus* Lamarck.

Specimen	NW	Hp	Ht	D	ap	h	d	h/d	R(T)
GK.H8549	8.0	19.6	20.8	10.2	3°	3.7	8.0	0.46	15-24

Legend as for Table 1.

sp., an index of middle Cenomanian, was obtained, according to the collector (Yutaka Koike), from the uppermost part of the sequence.

At present this species is known to occur only in Japan. In view of the worldwide distribution of *T. scheuchzerianus* and *T. costatus*, whether *T. complexus* has a more extensive distribution should be clarified.

Turrilites scheuchzerianus Bosc, 1801

Figure 3G

Turrilites scheuchzerianus Bosc, 1801, p. 190; Wright and Kennedy, 1996, p. 349 (with full synonymy)

Type.—"The status and whereabouts of the type material (Bosc, 1801, p. 190) have not been well established" (Wright and Kennedy, 1996, p. 349).

Material.—GK.H8563 [= previous GT.I-3154] (Figure 3G) collected by T. M. from a floated nodule at Loc. T32-33p, Saku-gakko-no-sawa, Nakagawa district. NMA-144, NMA-143 and NMA-142, collected by T. Nishino from "Loc. T" of Nakagawa district and described in Japanese by Hayakawa and Nishino (1999, p. 11, pl. 10, figs. a, b-c, e).

Descriptive remarks.—This species has been amply described and discussed by Wright and Kennedy (1996, p. 349, pl. 106, figs. 7, 8, 11, 12; pl. 107, figs. 1-7; text-figs. 137G, J; 138C, D, F-I, N; 139D-I; 140A, D-I; 143H; 147A, B) on the basis of numerous specimens from South England and extensive regions in the world. In addition to the specimens reported by Hayakawa and Nishino (*vide supra*), we know that a well preserved specimen occurred in the Zone of *Cunningtoniceras takahashii* at Loc. Ik1051b of the Ikushunbetsu Valley. It is quite similar to a British specimen (BMNH 30210, Wright and Kennedy, 1996, pl. 107, fig. 7), but it is not officially registered.

Distribution.—Middle part of the Cenomanian in Hokkaido. For the range in South England and the worldwide distribution see Wright and Kennedy, 1996, p. 353.

Turrilites costatus Lamarck, 1801

Figure 3 H, I

Turrilites costatus Lamarck, 1801, p. 102 (pars); Wright and Kennedy 1996, p. 354, pl. 103, figs. 1, 2, 5; pl. 104, figs. 1-4, 6, 8-10; pl. 105, figs. 1, 5, 6, 10, 12, 13, 16, 17, 19; pl. 106, figs.

1-6, 9, 10; text-figs. 137C; 139A-C; 142A, F, G; 143A-G, L-P (with full synonymy).

Type.—The specimen from Rouen figured by Douvillé (1904, p. 54a, fig. 1) in the Lamarck Collection is the lectotype designated by Kennedy (1971, p. 30). It is kept in the Muséum National d'Histoire Naturelle, Paris and was reillustrated by Wright and Kennedy (1996, text-fig. 142F).

Material and occurrence.—GK.H8560 [= GT.I-3157a] (Figure 3I) and GK.H8561 (not figured) collected by T. M. in 1938 on the left side of the River Shakotan [= Sakugawa]; NMA-176 and NMA-145 collected by T. Nishino from "Loc. T" on the right bank of the River Teshio, all in the Nakagawa district. GK.H1373 (Figure 3H) collected by T. M. in 1939 from Loc. Y524, Tengu-zawa of the Shuparo area (for the location see Matsumoto, 1942, pl. 25).

Descriptive remarks.—This specimen is well defined by previous authors, especially by Wright and Kennedy, 1996 (*vide supra*). GK.H8560 is a good example from Hokkaido, for it resembles the lectotype. NMA-145 could be regarded as a passage form to *T. acutus* Passy in its pointed tubercles. It is, however, quite similar to GK.H8560 (see ap, h/d and R(T) in Table 2).

Distribution.—The described specimens from Hokkaido are of middle Cenomanian age. For the range in England and also worldwide distribution of this species see Wright and Kennedy, 1996, p. 358.

Turrilites aff. *costatus* Lamarck, 1801

Figure 3 E, F

Material.—A single specimen, GK.H8549 [= previous S.4 3-5-7] (Figure 3E, F) collected by T. T. in 1968 at Loc. Ik1100 from the lower part of the Member IIb of the Mikasa Formation.

Descriptive remarks.—This is a small, probably immature specimen. It looks like *T. costatus*, but it shows a larger apical angle and lower whorls in comparison with the latter (compare Table 3 with Table 2). Its younger whorls show rather prominent tubercles in the upper row at moderate intervals (15-17 per whorl) and corresponding number of small tubercles in the lower row. Hence, the young shell is rather similar to *T. acutus* (*vide post*). The later whorls have tuberculated ribs like those of *T. costatus*, but they are rather

Table 4. Measurements of *Turrilites acutus* Passy.

Specimen	NW	Hp	Ht	D	ap	h	d	h/d	T
GK.H8559	3	40.0	77.0	32.5	27°	12.0	25.0	0.48	20
NMA-131	6	50.0	60.0	25.0	30°	9.0	19.0	0.47	18
GK.H8551	9	175.0	—	ca.77	—	ca.32	ca.67	ca.0.48	20

Legend as for Table 1. GK.H8551 is so much deformed that D and d are roughly estimated on the basis of the measured maximum and minimum dimensions.

crowded and numerous (24 in the preserved last whorl). There are closely set two rows of spirally elongated tubercles along the lower whorl seam. Thus, the shell of this stage is similar to the middle-aged shell of *T. complexus*. The morphological characters of the still later stage of this specimen are not known.

Despite the incomplete preservation, the specimen is so peculiar that it is tentatively described under the above heading. Its relation with *Mariella* (*M.*) *oehlerti* (Pervinçière, 1910) (see Matsumoto *et al.*, 1999) should be examined on the basis of further material.

Turrilites acutus Passy, 1832

Figures 3 J-M, 5, 6

Turrilites acutus Passy, 1832, p. 9, pl. 16, figs. 3, 4; Wright and Kennedy, 1996, p. 358, pl. 103, fig. 3; pl. 104, figs. 5, 7, 11; pl. 105, fig. 21; pl. 108; figs. 1-4, 8, 11, 12; text-figs. 138M; 141A; 146N-O (with full synonymy).

Lectotype.—The original of Passy, 1832, pl. 16, fig. 3 by the subsequent designation of Juignet and Kennedy, 1977, p. 65. For its photographic illustration see Wright and Kennedy, 1996, pl. 108, fig. 8a-c.

Material and occurrence.—GK.H8559 [= previous GT.I-3155] (Figure 3M) collected by T. M. in 1938 at Loc. T591d, a cliff on the left side of the River Abeshinai and NMA-131 collected by Nishino from "Loc. T" on the right bank of the River Teshio (Hayakawa and Nishio, 1999, p. 11, pl. 10, fig. h), both in the Nakagawa district. GS.G113, GS.G114 and GS.G127 (Figure 3K, J, L; reproduced here from Nishida *et al.*, 1997, pl. 7, figs. 10, 11 and pl. 12, fig. 5) collected by Kawashita and Egashira from a floated nodule in the Fuku-no-sawa, a branch of the River Shumarinai in the Soeushinai area (for the location see Nishida *et al.*, 1997, text-fig. 8). GK.H8551 [= previous S.43-4-30] (Figure 5) collected by T. T. in 1968 at Loc. Ik1102, north side of the River Ikushunbetsu, from the bed with *Cunningtoniceras takahashii* (Matsumoto). The above records of occurrence all indicate a middle Cenomanian age.

Diagnosis.—On the basis of the previous works the diagnosis may be written as follows. A species of *Turrilites* characterized by pointed tubercles of two rows on the flank, with a concave zone between them, and also clavate smaller tubercles of the third row along the lower whorl seam; the upper tubercles are bullate upward; weak radial ribs may run on the lower surface at least partly. Whorls are rather low, showing h/d below 0.5; hence the apical angle is normally 25°–30°.

Description.—GK.H8559 is similar to the lectotype and some other specimens of the corresponding growth stage, e. g., those illustrated by Wright and Kennedy (1996, pl. 106, figs. 1, 2, 8, 17) or by Atabekian (1985, pl. 29, figs. 1, 2, 4).



Figure 5. *Turrilites acutus* Passy, 1832. GK.H8551. Lateral view of a deformed specimen, $\times 0.8$. Photo courtesy of M. Noda.

On the basal surface of GK.H8559 weak radial ribs run from the clavate tubercles of the third row, showing a gentle curvature. The suture is well shown on this specimen (Figure 6). It is essentially similar to the suture illustrated by Atabekian (1985, pl. 29, figs. 1a, 1b).

GK.H8551 is a large specimen, although it is deformed. The diagnostic characters are clearly manifested by its main part, but in its later whorls the tubercles are rather blunt and transitional to longer ribs (see Figure 5).

Distribution.—Middle Cenomanian in Hokkaido. For the worldwide distribution see Wright and Kennedy (1996, p. 361).

Turrilites miroku sp. nov.

Figure 7

Material.—Holotype, here designated, is GK.H5916 from Loc. Ik1067p, Shimo-ichino-sawa of the Ikushunbetsu

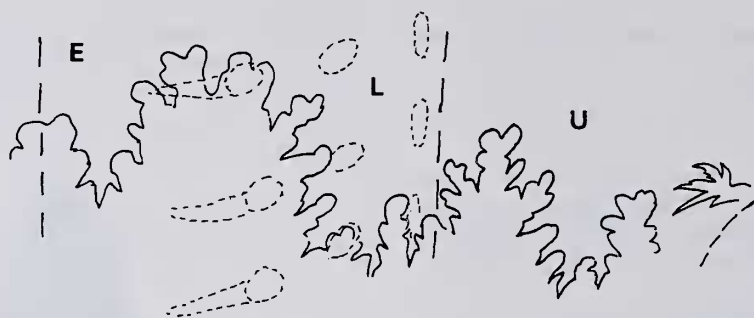


Figure 6. *Turrilites acutus* Passy, 1832. Septal suture of GK.H8559 at $h = 12.5$ mm. Broken line = whorl seam, dotted line = approximate outline of a tubercle or rib, E = external lobe, L = lateral lobe, U = umbilical lobe. A branch of an internal element (probably I) is extended from the unexposed side. Figure is about $\times 4$. Drawing by T. M.

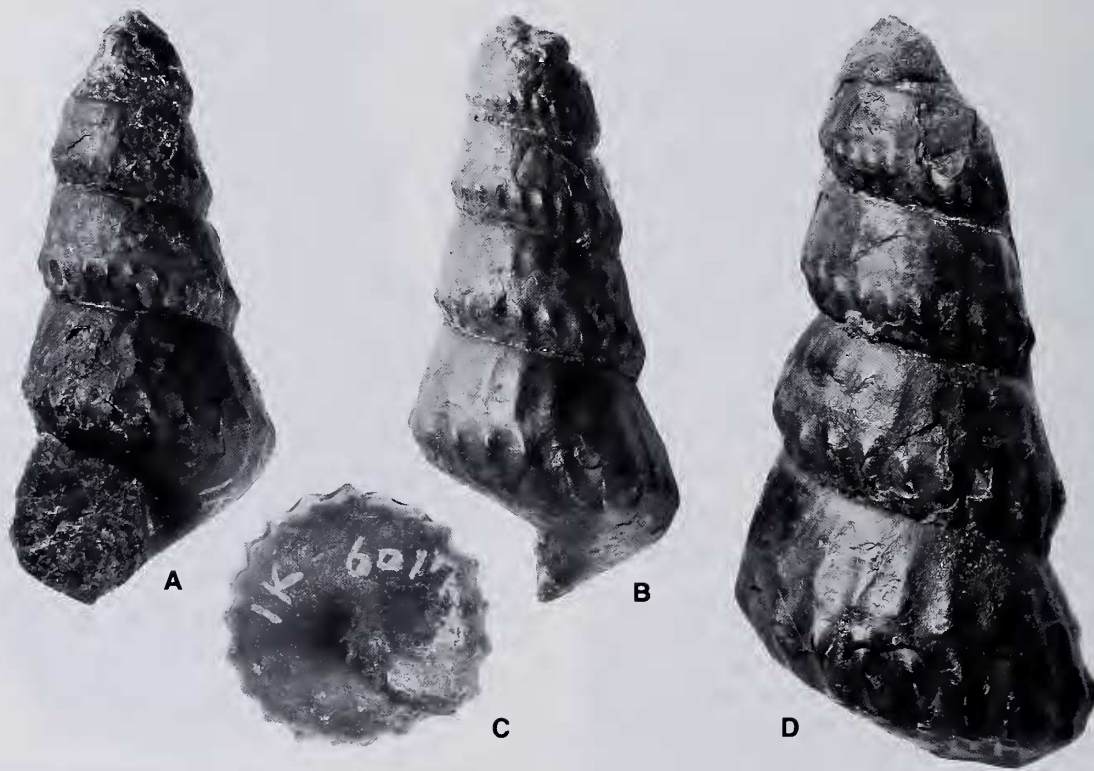


Figure 7. *Turrilites miroku* sp. nov. GK.H5916 (holotype). Two lateral (A and B turned 180°) and basal (C) views; also another lateral view (D) which is turned 120° anticlockwise from A. A–C are $\times 1$; D is $\times 1.5$. Photos courtesy of M. Noda.

Table 5. Measurements of *Turrilites miroku* sp. nov.

Specimen	NW	Hp	Ht	D	ap	h	d	h/d	R(T)
GH.H5716	4	68.0	107.0	31.0	21°	13.0	23.0	0.57	22

Legend as for Table 1.

Valley.

Specific name.—Miroku [= Maitraya in Sanskrit], a deity in Buddhism, who will help people in the remote future.

Diagnosis.—A species of *Turrilites* with small apical angle. Each whorl is characterized by downward steeply inclined flat flank, with its maximum diameter at the level of lower tubercles. The upper, longer ribs rather weak and faintly tuberculated at their lower end. Lower ribs short, prorsiradial, and sharply tuberculated in their upper part, terminating at the smaller tubercles of the third row aligned along the lower whorl seam. The lower (or basal) whorl face gently convex and nearly smooth.

Description.—The holotype consists of four whorls of 68 mm in total height. It lacks the whorls of the early and also the last stages. Assuming that one more whorl is the lost body chamber, the restored shell would be at least 105 mm in total height and 40 mm in diameter of the basal surface. The estimated apical angle is 21°.

Each whorl of this specimen shows a peculiar shape, for its main part of the flank is flat, without convexity, and steeply inclines downward to the level of the prominent tubercles in the lower part, where the maximum diameter is located. Downward from this level, the lower portion of the flank inclines inward for a short distance to the lower whorl seam. Whorls are tightly in contact. The ratio of height (h) to diameter (d) in each whorl, excluding the unexposed lower surface, distinctly exceeds 0.5 (see Table 5).

The ornament is also peculiar to this species. The ribs on the upper flank are weak but moderately numerous, 22 per whorl. Each of them terminates at a small and blunt tubercle. Below this first row of tubercles there is a narrow and shallow, spiral groove; then comes the second row of moderately prominent tubercles, where the flank is somewhat angular at the tubercle or shouldered along the interspace. A short but sharp rib runs from each tubercle of the second row downward to a less prominent small tubercle of the third row, which runs along the lower whorl seam. The upper ribs run transversally with slight curvature, whereas the lower ribs are clearly prorsiradial together with the bullate tubercles. Lower or basal surface of the whorl is almost smooth and gently inflated around a narrow umbilicus.

Septal sutures are partly exposed but not clearly traced.

Comparison.—At present only one specimen (holotype) is available for this species. Its approximate size described above is somewhat larger than the lectotype of *Turrilites acutus* Passy, 1832 (pl. 16, fig. 3; reillustrated by Wright and Kennedy, 1996, pl. 105, fig. 5) and probably smaller than the lectotype of *Turrilites wiestii* Sharpe, 1857 (pl. 27, fig. 8; reillustrated by Wright and Kennedy, 1996, pl. 105, fig. 18).

Some young shells of *Turrilites scheuchzerianus* Bosc, 1801, exemplified by such specimens as illustrated by Wright and Kennedy (1996, text-fig. 138C–D, F–G, N; pl. 107, fig. 1), are somewhat similar to the present species in

showing a downward broadening whorl, nodelike swelling, if not tuberculation, of the lower ribs, and the smooth basal surface. However, in typical examples of *T. scheuchzerianus* the apical angle is smaller, the whorl flank is gently convex, and the tubercles are not developed.

With respect to the characteristic whorl shape, the present species is similar to a certain form of *T. wiestii* represented by a group of specimens illustrated by Wright and Kennedy, 1996, pl. 105, figs. 7, 8, 11 and pl. 108, figs. 9, 13. It is, however, different from the above form as well as the lectotype of *T. wiestii* (Sharpe, 1857, pl. 27, fig. 8; reillustrated by Wright and Kennedy, 1996, pl. 105, fig. 18) in its more numerous and less distant ribs with weaker tubercles. The lectotype shows a dissimilar whorl shape.

This species could be referred to the subgenus *Ostlingoceras* (*Ostlingoceras*) Hyatt, 1900, but in the latter the transversal ribs are more numerous and crowded, the tubercles of the second row are smaller and weaker, and the lower (or basal) surface of the whorl has radial ribs, with third and/or fourth rows of small tubercles on its marginal zone. The ribs on the holotype of *T. miroku* are 22 per whorl, showing nearly the same density as that of *T. costatus* (see Tables 2 and 5).

Discussion.—This species is somewhat peculiar in its morphological characters. In this paper it is assigned at least tentatively to *Turrilites* on the grounds of the above comparison.

The holotype of this species was in a transported nodule, which can be inferred to have been derived from somewhere in the lower Cenomanian on account of its having been recovered close to Loc. 1k1065b, where a lower Cenomanian species, *Ostlingoceras* (*O.*) *bechei* (Sharpe) was obtained (see Matsumoto and Takahashi, 2000, p. 262). It should be noted that *T. wiestii* is recorded from the lower Cenomanian of England near the boundary of the *Mantelliceras dixonii* Zone and the *Acanthoceras rhotomagense* Zone (Wright and Kennedy, 1996, p. 354).

At any rate, we have to get more material to clear up questionable points about the systematic and biostratigraphic allocation of the present species.

Genus *Mesoturrilites* Breistroffer, 1953

Type species.—*Turrilites aumalensis* Coquand, 1862.

Diagnosis.—Turrilitid ammonoids with four rows of tubercles or ribs; the first row on the main part of flank made up of ribs and/or tubercles, the second and the third rows of small tubercles on spirally elongated, narrow ridges separated by a groove; the fourth row of small tubercles on the marginal zone of the lower whorl surface where radial ribs run to a narrow umbilicus (modified from Matsumoto and Inoma, 1999, p. 37).

***Mesoturritiles cf. aumalensis* (Coquand, 1862)**

Figure 3 N

Compared.—*Turritiles aumalensis* Coquand, 1862, p. 323, pl. 35, fig. 3.*Mesoturritiles aumalensis* (Coquand, 1862). Wright and Kennedy, 1996, p. 346, pl. 98, fig. 5; pl. 105, figs. 2, 3, 14; text-figs. 134J, K; 138S-U, W; 146A-G (with full synonymy).

Material.—GK.H8562 [= previous GT.I-3310] (Figure 3N), collected by T. M. in 1938 at Loc. T591a, the lowest part of a sequence of strata exposed on the right side of the River Abeshinai in the Nakagawa district.

Descriptive remarks.—This specimen is small and incompletely preserved. It shows a pyramidal shape, conical tubercles of moderate intensity and density at about the midflank, and corresponding number of spirally elongated tubercles in two rows, with a narrow groove in between, along the lower whorl seam. The clavate tubercles of the fourth

row and radial ribs arising from them are faintly discernible on the lower face. Although the preservation is insufficient, this specimen can be called *Mesoturritiles cf. aumalensis*. It occurs at the level immediately below that of *Turritiles complexus* (*vide ante*).

***Mesoturritiles pombetsensis* sp. nov.**

Figures 8, 9

Material and occurrence.—Holotype, here designated, is GK.H8532 [= previous S. 37.7.17] (Figure 8A–D) collected by T. T. in 1963 from a transported nodule on the Onkonosawa, a branch of the River Ponbetsu in the Mikasa district. Paratype is GK.H8548 (Figure 8E, F), collected by T. T. at Loc. Ik1101 on the right side of the R. Ikushunbetsu. The fossiliferous sandy rocks which contain the above specimens are referred to the lower part of the Member IIb of the Mikasa Formation.

Diagnosis.—Pyramid-shaped species of *Mesoturritiles*

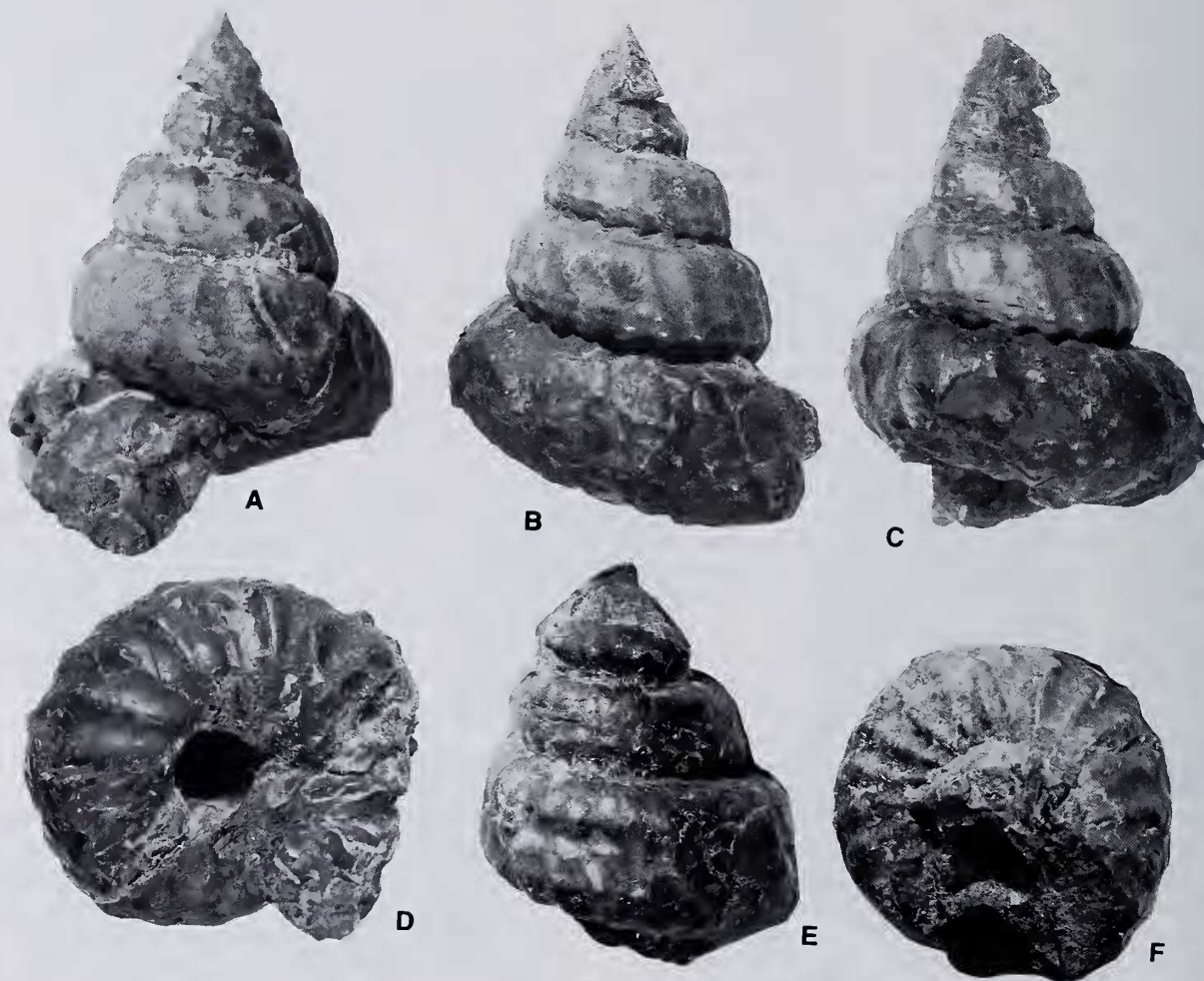


Figure 8. A–F. *Mesoturritiles pombetsensis* sp. nov. Three lateral (A, B and C turned about 120° anticlockwise) and basal (D) views of GK.H8532 (holotype), slightly, over natural size. Lateral (E) and basal (F) views of GK.H8548, $\times 1.67$. Photos courtesy of M. Noda.

Table 6. Measurements of *Mesoturrilites pombetsensis* sp. nov.

Specimen	NW	Hp	Ht	D	ap	h	d	h/d	R(T)
GK.H8532	5.5	55.0	60.0	46.0	47°	14.7	33.7	0.44	18
GK.H8548	3.0	29.0	42.0	28.0	45°	8.3	19.3	0.43	22

Legend as for Table 1.

with moderate apical angle, ornamented by fairly coarse ribs on the upper flank, each of which is provided with a node at about the midflank immediately above a shallow concave zone; also two closely set rows of spirally elongate tubercles in the lower part with a groove in between. In more or less later stages the prorsiradiate ribs run across the concave zone and the groove. The ribs further extend radically on the gently convex lower (or basal) surface, with tubercles of the fourth row on the margin of the circular base.

Description.—The holotype consists of nearly six septate whorls, with a fraction of crushed body chamber at the preserved end (Figure 8A, D). It is moderately large (Table 6). A single paratype is small and corresponds to the young part of the holotype. The entire shell shape is pyramidal; the exposed outer face of the whorl consists of a nearly flat or gently inclined upper portion, steeply inclined main part, and incurved lower portion. The interwhorl junction is deep.

The ornament somewhat changes with growth. In the early growth stage the upper ribs are very coarse and tuberculated at their lower end. This is well manifested at the early stage (with $d < 15$ mm) of the paratype, but is less clear in the holotype. Below the zone of upper ribs a shallowly concave, spiral zone runs at about the midflank. In the middle to late growth stages, the ribs are elongated and the spiral groove is reduced. The prorsiradiate ribs run across the shallowing groove and connect themselves with the spirally elongated tubercles of the second and third rows. They extend to the radial ribs on the lower surface. The ribs are curved at about the rounded, small tubercles of the fourth row. On the well preserved lower face, delicate spiral lines or lirae may be observed and tiny dots may be discernible at the crossing points with the radial ribs (Figure 8 D, F).

Septal suture is deeply and finely indented. Moreover, the extra branches of a lobe (l?) are extended from the other side (Figure 9).

Comparison and discussion.—The holotype of this species is the largest among hitherto reported specimens of *Mesoturrilites*. If its body chamber is preserved, it would be about 80 mm in height and 75 mm in basal diameter. However, it is actually difficult to estimate the real size of the adult shell in the previously described species, because their types are incompletely preserved.

The present species is somewhat allied to *Mesoturrilites aumalensis* (Coquand, 1862) (p. 323, pl. 35, fig. 3), redefined by Wright and Kennedy (1996, *vide ante*) in the general shell shape and the ornamentation of the young stage. In later growth stages ribs become predominant in the former, whereas tubercles characterize the latter. In this respect this species may be somewhat allied to *M. corrugatus* Wright and Kennedy (1996, p. 348, pl. 98, figs. 4, 17), but the ribs in the latter are narrower and sharper, without such

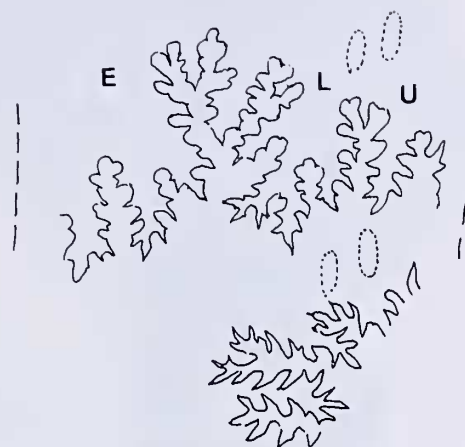


Figure 9. *Mesoturrilites pombetsensis* sp. nov. External suture of GK.H8532 (holotype) at $h = 15$ mm. Figure is about $\times 4$. Symbols as for Figure 6. Drawing by T. M.

nodes as seen on the ribs of *M. pombetsensis*.

Distribution.—At present this species is represented by only two specimens from the lower part of the Cenomanian in Hokkaido. Although they are fairly well preserved, more material should be searched for to ascertain the vertical range and geographical distribution.

Genus *Mariella* Nowak, 1916

Subgenus *Mariella* (*Mariella*) Nowak, 1916

Remarks.—Altogether 10 species of *M. (Mariella)* from Hokkaido have been recently described (Matsumoto *et al.*, 1999; Matsumoto and Kawashita, 1999; Matsumoto and Kijima, 2000; Matsumoto *et al.*, 2000). Two more species are described below.

Mariella (Mariella) cenomaniensis (Schlüter, 1876)

Figure 10

Type.—Lectotype, by the subsequent designation of Kennedy, 1971 (p. 29), is the original of Schlüter, 1876, pl. 37, fig. 6. The specimen illustrated by Wright and Kennedy (1996, text-fig. 141B) is supposed to be this specimen.

Material and occurrence.—GK.H8557 [= previous S.55-9-14] (Figure 10A, B), collected by T. T. in 1960 at the point of the Hachigatsu-zawa, near the confluence with the branch rivulet called the Okufutamata-zawa. It is in a calcareous nodule of fine sandstone derived probably from the lower



Figure 10. *Mariella (Mariella) cenomanensis* (Schlüter, 1876). Lateral (A) and basal (B) views of GK.H8557, $\times 1.5$. Photos courtesy of M. Noda.

Cenomanian part exposed upstream from this locality (see the Geological Map of Kamiashibetsu by Shimizu *et al.*, 1953).

Description.—This single specimen is small but it shows 9 whorls. Its estimated apical angle is low (about 20°), although it is somewhat deformed. The outer exposed whorl face is convex and the whorl junction is deeply impressed. The exposed part of each whorl in lateral view is comparatively high, showing $h/d = 0.62$ in a measured part.

The tubercles in two rows on the main part of the flank are coarse, numbering 18 per whorl in each row. There is a smooth sloping zone above the upper row of subrounded tubercles. The tubercles of the second row are somewhat clavate. There are spirally elongated tubercles of the closely set third and fourth rows at about the edge between the lateral and lower (or basal) faces.

Remarks.—This specimen resembles smaller examples of *M. (M.) cenomanensis*, e. g., those described by Kennedy (1971, p. 28, pl. 8, fig. 10) and Atabekian (1985, p. 41, pl. 10, figs. 1–6). It is certainly identified with this species on the grounds of the described characters. The apical angle 23° by Wright and Kennedy (1996, p. 342) is somewhat larger than that in ours or in Atabekian's small specimens. This may depend on estimations made from the whorls of different growth stages.

Distribution.—*M. (M.) cenomanensis* has been reported to occur in the lower Cenomanian of various regions in the world (see Wright and Kennedy, 1996, p. 344).

***Mariella (Mariella) aff. circumtaeniata* (Kossmat, 1895)**

Figure 11

Compared. —

Turritites circumtaeniatus Kossmat, 1895, p. 141, pl. 18, figs. 4, 5.
Mariella (Mariella) circumtaeniata (Kossmat, 1895). Klinger and Kennedy, 1978, p. 26, pl. 5, figs. A–C; text figs. 3G, 6D (with full synonymy)

Material.—IGPS 108380 (Figure 11A, B), collected by Makoto Okamura in 1972, at his Loc. AB14 [= Loc. T590c of Matsumoto (1942)] on the left side of the River Abeshinai in the Nakagawa district.

Descriptive remarks.—This specimen is a highly distorted body chamber, measured as 106×50 mm in the basal outline. The flank on the figured part (Figure 11A) is well rounded, but the other side is flattened. The ornament consists of three rows of tubercles and the looped ribs. The looping or intercalation of the ribs is frequent in the space between the upper row of tubercles and the upper whorl seam. The interval between the upper and middle rows of tubercles is slightly wider than that between the middle and lower rows. The coiling is sinistral and the ribs are prorsiradiate, extending to the radial ones on the basal surface.

The tubercles of the first row and the ribs of the upper part are very weak. Whether this is the original character or a secondary feature created by weathering is not clear. As the body chamber alone is available, we have to leave the present material in open nomenclature. More material should be searched for to clear up the classification.

M. (Mariella) circumtaeniata has been reported to occur in the upper Albian of southern India, Madagascar, South Africa (Zululand) and (?) New Zealand (see Klinger and Kennedy, 1978, p. 26). The locality of the present specimen is referred to the Unit IIa (lower part of the Cenomanian) in the Abeshinai Valley.



Figure 11. *Mariella* (*Mariella*) aff. *circumtaeniata* (Kossmat, 1895). Lateral (A) and basal (B) views of IGPS 108380 (a crushed body chamber). A is $\times 1$ and B is $\times 0.8$. Photos courtesy of M. Noda.

Conclusions

To conclude this paper the following results are summarized.

(1) Three well known species of worldwide distribution, *Turrilites scheuchzerianus* Bosc, *T. costatus* Lamarck and *T. acutus* Passy, occur in the middle Cenomanian of Japan.

(2) *Turrilites complexus* sp. nov. is established on several specimens from the Mikasa and Nakagawa districts of Hokkaido, which were previously misidentified with *T. costatus*. This new species shows in youth some features of *T. scheuchzerianus* and later those of *T. costatus*. It retains also some characters of *Mariella* (*Mariella*) *oehlerti* (Pervinquière).

(3) Another new species, *T. miroku*, based on a single specimen from Mikasa, is similar in some respects to a certain form of *T. wiestii* Sharpe, but distinct from the lectotype of the latter. Further study of more material is required.

(4) *Mesoturrilites* cf. *aumalensis* (Coquand) is found in the lower Cenomanian of Nakagawa. Furthermore, *M. pombetsensis* sp. nov. is erected on the specimens from the lower Cenomanian of Mikasa. It has distinct ribs and weaker tubercles.

(5) *Mariella* (*Mariella*) *cenomanensis* (Schlüter), another cosmopolitan, is first recorded from Hokkaido.

(6) *M. (M.)* aff. *circumtaeniata* (Kossmat) is reported from Nakagawa, but more material is required for adequate taxonomy and age correlation.

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